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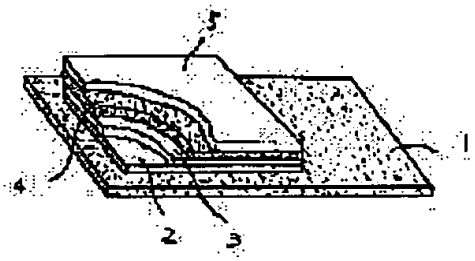
(54) PIEZOELECTRIC/ELECTROSTRICTIVE FILM TYPE ACTUATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a piezoelectric/electrostrictive film type actuator which can obtain a desired piezoelectric/electrostrictive characteristic by improving the adhesion between a thin ceramic substrate and a piezoelectric/electrostrictive film formed on the substrate an, at the same time, by making the piezoelectric/ electrostrictive film compact.

SOLUTION: A piezoelectric/electrostrictive film type actuator is constituted by successively forming a first conductive film 2 composed of Pt, a second conductive film 3 composed of Pt-W, Pt-Rh, or Rh and having a higher melting point than the first conductive film 2 has or a second conductive film 3 composed of Pt-Au, Pt-Ag, or Pt-Pd and having a lower melting point than the first conductive film 2 has, a piezoelectric/electrostrictive film 4, and an electrode film 5 on a thin ceramic substrate 1 and uniting the substrate 1 and films 2, 3, 4, and 5 in one body.



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ABSTRACT:

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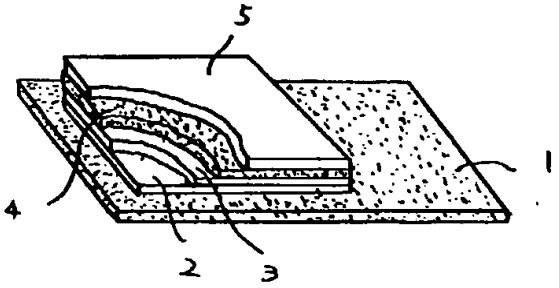
(54)【発明の名称】　圧電／電歪膜型アクチュエータ

(57)【要約】
【課題】薄肉のセラミック基板１上に形成する圧電／電歪膜との密着性を高めるとともに、圧電／電歪膜４を緻密化させて所望の圧電／電歪特性が得られる圧電／電歪膜アクチュエータを提供する。
【解決手段】薄肉のセラミック基板１上にＰｔからなる第一導電膜２を形成するとともに、該第一導電膜２上に第一導電膜２より融点の高いＰｔ－Ｗ、Ｐｔ－Ｒｈ、あるいはＲｈからなる第二導電膜３を積層するか、あるいは上記第一導電膜３上に第一導電膜２より融点の低いＰｔ－Ａｕ、Ｐｔ－Ａｇ、あるいはＰｔ－Ｐｄからなる第二導電膜３を積層し、該第二導電膜３上に圧電／電歪膜４及び電極膜５を順次積層一体化して圧電／電歪膜型アクチュエータを構成する。



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【特許請求の範囲】

【請求項1】薄肉のセラミック基板上にPtからなる第一導電膜を形成し、該第一導電膜上にPt－W、Pt－Rh、RhあるいはPt－Au、Pt－Ag、Pt－Pdのいずれかからなる第二導電膜を積層し、該第二導電膜上に圧電／電歪膜及び電極膜を順次積層一体化してなる圧電／電歪膜型アクチュエータ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、薄肉のセラミック基板上にPtからなる第一導電膜とPtを含む合金からなる第二導電膜を介して圧電／電歪膜及び電極膜を順次積層一体化してなる圧電／電歪膜型アクチュエータに関するものであり、例えば、インクジェット記録ヘッド、マイクロホン、振動体、発振体、各種変位センサー、ポンプ、スイッチなどに好適なものである。

【0002】

【従来の技術及び発明が解決しようとする課題】近年、精密加工分野や光学分野においては、サブミクロンオーダーでの位置制御が求められており、この位置制御に強誘電体等の圧電／電歪材料に電界を加えたときに起こる逆圧電効果や電歪効果に基づく変位あるいはその逆の現象を利用した圧電／電歪膜型アクチュエータが使用されている。

【0003】例えば、インクジェット記録ヘッドにおいては、ユニモルフ型やバイモルフ型等の圧電／電歪膜型アクチュエータが使用されており、小型化、高密度化、低電圧駆動、高速応答性等の特性が要求されている。

【0004】図4に一般的な圧電／電歪膜型アクチュエータの構造を示すように、このアクチュエータはユニモルフ型と呼ばれるもので、薄肉の絶縁性セラミック基板1上に該セラミック基板1と密着性の高いPtからなる下側電極膜6を形成するとともに、該下側電極膜6上にジルコン酸チタン酸鉛、マグネシウムニオブ酸鉛、ニッケルニオブ酸鉛、アンチモンスズ鉛等の圧電材料からなる圧電／電歪膜4を積層し、さらに上記圧電／電歪膜4上にPt、Pd、Rh等の高融点金属からなる上側電極膜5を積層一体化したものがあった（特開平6－260694号公報参照）。

【0005】このようなセラミック基板1上に下側電極膜6、圧電／電歪膜4、上側電極膜5からなる圧電／電歪駆動部7を形成したものは、低電圧駆動で高速応答性を有するとともに、電界誘起歪みの横効果による大きな屈曲変位が得られるという利点があった。

【0006】しかしながら、Ptからなる下側電極膜6上に直接圧電／電歪膜4を積層一体化すると、圧電／電歪膜4を十分に緻密化させることができないために下側電極膜6と上側電極膜5に通電して圧電／電歪膜4に電界誘起歪みを発生させたとしても所望の圧電／電歪特性が得られず、大きな屈曲変位が得られないといった課題があった。

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【0007】

【課題を解決するための手段】そこで、本件発明者らは、Ptからなる導電膜上に積層した圧電／電歪膜を緻密化させることができない原因について研究したところ、上記圧電材料からなる圧電／電歪膜の熱処理温度領域（900～1300℃）において、圧電／電歪膜を構成する圧電材料とPtからなる電極膜との密着性が高いために圧電材料の収縮が阻害され、その結果、圧電／電歪膜を緻密化できないことを知見した。

【0008】そして、本件発明者は、圧電／電歪膜を十分に緻密化し、所望の圧電／電歪特性が得られる圧電／電歪膜型アクチュエータについて、さらに鋭意研究を重ねたところ、Ptからなる導電膜と圧電／電歪膜との間に、Ptからなる導電膜より融点の高い導電膜を介在させるか、あるいは逆にPtからなる導電膜より融点の低い導電膜を介在させることにより、圧電／電歪膜を緻密化して所望の圧電／電歪特性を発揮できることを突き止めた。

【0009】即ち、本発明は、薄肉のセラミック基板上にPtからなる第一導電膜を形成し、該第一導電膜上に第一導電膜より融点の高いPt－W、Pt－Rh、Rhのいずれかからなる第二導電膜あるいは上記第一導電膜より融点の低いPt－Au、Pt－Ag、Pt－Pdのいずれかからなる第二導電膜を積層し、該第二導電膜上に圧電／電歪膜及び電極膜を順次積層一体化して圧電／電歪膜型アクチュエータを構成したものである。

【0010】

【作用】本願発明によれば、薄肉のセラミック基板上にPtからなる第一導電膜を形成してあることから、セラミック基板との密着性を高めることができ、圧電／電歪膜を駆動させたとしても第一導電膜がセラミック基板より剥離することがない。

【0011】また、本発明によれば、上記Ptからなる第一導電膜上に第一導電膜より融点の高いPt－W、Pt－Rh、Rhのいずれかからなる第二導電膜を介して圧電／電歪膜を積層一体化するか、あるいは上記Ptからなる第一導電膜上に第一導電膜より融点の低いPt－Au、Pt－Ag、Pt－Pdのいずれかからなる第二導電膜を介して圧電／電歪膜を積層一体化してあることから、圧電／電歪膜を緻密化させることができる。即ち、第二導電膜として第一導電膜より融点の高いPt－W、Pt－Rh、Rhのいずれかの金属や合金を用いることにより、圧電／電歪膜の熱処理温度領域（900～1300℃）において、圧電／電歪膜を構成する圧電材料と第二導電膜との密着力を低下させることができるために圧電材料が収縮しやすくなり、圧電／電歪膜を緻密化させることができ、また、第二導電膜として第一導電膜より融点の低いPt－Au、Pt－Ag、Pt－Pdのいずれかの合金を用いることにより、、圧電／電歪膜

の熱処理温度領域（900～1300℃）において、第二導電膜の表面を軟化あるいは剛性を低下させることができるために圧電材料が収縮しやすくなり、圧電／電歪膜を緻密化させることができる。

【0012】

【発明の実施の形態】以下、本発明の実施形態について説明する。なお、図4と同一部分については同一符号で示す。

【0013】図1は本発明の圧電／電歪膜型アクチュエータの一例を示す斜視図である。このアクチュエータはユニモルフ型と呼ばれるもので、薄肉のセラミック基板1上にPtからなる第一導電膜2を形成し、該第一導電膜2上に第一導電膜2より融点の高いPt－W、Pt－Rh、Rhのいずれかからなる第二導電膜3を積層するか、あるいは上記第一導電膜2上に第一導電膜2より融点の低いPt－Au、Pt－Ag、Pt－Pdのいずれかからなる第二導電膜3を積層し、該第二導電膜3上に圧電／電歪膜4を積層したあと、圧電／電歪膜4上に電極膜5を積層したもので、各膜2～5は熱処理によってセラミック基板1上に順次積層一体化したものである。

【0014】また、図2は本発明の圧電／電歪膜型アクチュエータの他の例を示す斜視図であり、このアクチュエータはバイモルフ型と呼ばれるもので、薄肉のセラミック基板1の上下面にPtからなる第一導電膜2を形成し、該第一導電膜2上に第一導電膜2より融点の高いPt－W、Pt－Rh、Rhのいずれかからなる第二導電膜3を積層するか、あるいは上記第一導電膜2上に第一導電膜2より融点の低いPt－Au、Pt－Ag、Pt－Pdのいずれかからなる第二導電膜3を積層し、該第二導電膜3上に圧電／電歪膜4を積層したあと、圧電／電歪膜4上に電極膜5を積層したもので、各膜2～5は熱処理によってセラミック基板1上に順次積層一体化したものである。

【0015】図1及び図2に示す圧電／電歪膜型アクチュエータにおいて、セラミック基板1を構成する材質としては、アルミナセラミックス、炭化珪素セラミックス、窒化珪素セラミックス、ジルコニアセラミックス、あるいはランタンクロマイト系等のペロブスカイト型の結晶構造を有するセラミックスを用いることができ、これらの中でも特にジルコニアセラミックス及びペロブスカイト型の結晶構造を有するセラミックスはPtからなる第一電極膜2との反応が少ないため、セラミック基板1の構成成分が第一導電膜2上に積層する圧電／電歪膜4に拡散することを防ぐことができるため、圧電／電歪膜4の特性を劣化させることがない。

【0016】なお、圧電／電歪膜4を駆動させるにあたっては、セラミック基板1が絶縁性のセラミックスである場合には、第一導電膜2及び／又は第一導電膜3を下側電極とし、セラミック基板1が導電性を有するセラミックスである場合には、セラミック基板1を下側電極とすれば良い。

【0017】また、電界誘起歪みを発生する圧電／電歪膜4を構成する材質としては、ジルコン酸チタン酸鉛（PZT系）を主成分とする材料、マグネシウムニオブ酸鉛（PMN系）を主成分とする材料、ニッケルニオブ酸鉛を主成分とする材料、アンチモンスズ酸鉛を主成分とする材料、チタン酸鉛を主成分とする材料、チタン酸バリウムを主成分とする材料、さらにはこれら主成分の複合材料等を用いることができ、好ましくはマグネシウムニオブ酸鉛とジルコン酸鉛とチタン酸鉛を主成分とする材料もしくはニッケルニオブ酸鉛とマグネシウムニオブ酸鉛とジルコン酸鉛とチタン酸鉛を主成分とする材料により形成することが好ましい。

【0018】さらに、圧電／電歪膜4上に積層する電極膜5の材質としては、Pt、Au、Pb、Rh等の高融点金属や、Pt－Au、Pb－Ag、Pt－Pb等の合金を主成分とする電極材料を用いることができる。

【0019】そして、上記セラミック基板1上に形成する第一導電膜2はPtを用いることが重要である。上記Ptは他の高融点金属と比較してセラミック基板1との密着性に優れることから、圧電／電歪膜4を駆動させてセラミック基板1を屈曲変位させても剥離することがない。

【0020】また、上記Ptからなる第一導電膜2と圧電／電歪膜4との間には第一導電膜2より融点の高いPt－W、Pt－Rh、あるいはRhからなる第二導電膜3を介在させるか、あるいは第一導電膜2より融点の低いPt－Au、Pt－Ag、あるいはPt－Pdからなる第二導電膜3を介在させることが重要である。

【0021】即ち、Ptからなる第一導電膜2上にPtより融点の高い第二導電膜3を設けることで、上記第二導電膜3上に形成した圧電／電歪膜4を緻密化するために熱処理を加えたとしても、前記圧電材料の熱処理温度領域（900～1300℃）において第一導電膜2の表面が軟化したり剛性が低下するようなことがないため、圧電／電歪膜4を構成する圧電材料と第二導電膜3との間の密着力が小さくなり、圧電材料が収縮しやすくなるため、圧電／電歪膜4を緻密化することができ、他方、Ptからなる第一導電膜2上にPtより融点の低い第二導電膜3を設けることで、上記第二導電膜3上に形成した圧電／電歪膜4を緻密化するために熱処理を加えると、前記圧電材料の熱処理温度領域（900～1300℃）において第一導電膜2の表面を大きく軟化させたり剛性を大きく低下させることができるため、圧電／電歪膜4を構成する圧電材料が収縮しやすくなり、圧電／電歪膜4を緻密化することができる。

【0022】そして、Ptより融点の高いPt－W、Pt－Rh、RhあるいはPtより融点の低いPt－Au、Pt－Ag、Pt－Pdはいずれも Ptを含む合金あるいはPtと馴染みやすいRhからなるため、第一導

電膜2との密着性を高めることができる。

【0023】その為、いずれの材質からなる第二導電膜3を用いたとしても圧電／電歪膜4を緻密化することができるため、圧電／電歪膜4を駆動させれば所望の圧電／電歪特性を得ることができ、低電圧駆動でありながら大きな屈曲変位が得られる圧電／電歪膜型アクチュエータを得ることができる。

【0024】ただし、このような効果を得るためには、第二導電膜3としてPtより融点の高いPt－W、Pt－Rh、Rhを用いる時には第一導電膜2を構成するPtより融点が50℃以上高いものが望ましく、また、第二導電膜3としてPtより融点の低いPt－Au、Pt－Ag、Pt－Pdを用いる時には第一導電膜2を構成するPtより融点が30～400℃の範囲で低いものが望ましい。

【0025】また、圧電／電歪膜4により発生する電界誘起歪みを効率良くセラミック基板1に伝達させて設計通り屈曲変位させるには、第一導電膜2及び第二導電膜3の合計厚み幅を1～5μm、好ましくは3～4μmとすることが良い。これら導電膜2，3の合計厚み幅が5μmより厚くなると、圧電／電歪膜4の電界誘起歪みが導電膜2，3で吸収されるために薄肉のセラミック基板1を設計通り屈曲変位させることができないからであり、逆に、1μm未満では均一な厚み幅を持った導電膜2，3の形成が難しく、ピンホール等がある場合、圧電／電歪特性を劣化させてしまうからである。

【0026】ところで、図1又は図2に示す圧電／電歪膜型アクチュエータを製作するには、予め焼結した前記セラミック材料からなる薄肉のセラミック基板1を用意し、この基板1の一主面又は上下面に、Ptのペーストやスラリーをスクリーン印刷法やディピッング法、あるいは塗布など周知の膜形成手段により敷設し、500～1400℃の温度で熱処理を施してPtからなる第一導電膜2を形成したあと、該第一導電膜2上にPtより融点の高いPt－WやPt－Rhの合金、あるいはRhのペーストやスラリーをスクリーン印刷法やディピッング法、あるいは塗布など周知の膜形成手段により敷設し、1000～1800℃の温度範囲で熱処理を施すことによりPt－W、Pt－Rh、Rhのいずれかよりなる第二導電膜3を積層するか、あるいは上記第一導電膜2上にPtより融点の低いPt－Au、Pt－Ag、Pt－Pdの合金のペーストやスラリーをスクリーン印刷法やディピッング法、あるいは塗布など周知の膜形成手段により敷設し、500～1300℃の温度範囲で熱処理を施すことによりPt－Au、Pt－Ag、Pt－Pdのいずれかよりなる第二導電膜3を積層する。さらに、上記第二導電膜3上に圧電／電歪膜4を構成する前記圧電材料（PZT、PMNなど）を含むペーストやスラリーをスクリーン印刷法やディピッング法、あるいは塗布など周知の膜形成手段により敷設し、1100～1400℃の温度で熱処理を施すことにより圧電／電歪膜4を積層したあと、さらに圧電／電歪膜4の上に電極膜5を構成する前記電極材料を含むペーストやスラリーをスクリーン印刷法やディピッング法、あるいは塗布など周知の膜形成手段により敷設したあと、500～1200℃の温度で熱処理を施すことにより電極膜5を積層一体化すれば良い。

【0027】かくして本発明の圧電／電歪膜型アクチュエータによれば、圧電／電歪膜4が緻密でかつほぼ完全に焼結していることから、良好な圧電／電歪特性を発揮させることができるため、低電圧駆動でありながら設計通りの大きな屈曲変位が得られるとともに、応答速度を高めることができる。

【0028】その為、本発明の圧電／電歪膜型アクチュエータを、例えばインクジェット記録ヘッドに用いれば、インクの吐出量を高めることができるとともに、印字速度を速めることができ、また、他にマイクロホン、振動体、発振体、各種変位センサー、ポンプ、スイッチなどとしても好適に使用することができる。

【0029】（実施例）以下、図1に示す圧電／電歪膜型アクチュエータの具体例について説明する。

【0030】（実施例1）薄肉のセラミック基板1として、平均粒径0．2μmのY_2O_3を3mol%含有する部分安定化ZrO_2の粉末にアクリル酸エステル共重合体水性エマルジョンを主成分とするバインダーを添加し、ボールミルにて20時間混合した後、テープ状に成形し、1200～1400℃で1～5時間焼成して厚みが約0．2mmのジルコニアセラミックスからなるセラミック基板1を製作した。そして、このセラミック基板1上に、有機物バインダーに対して平均粒径が1μmのPtを69重量%含有させたPtのペーストを乳剤厚み6μmの製版を用いてスクリーン印刷法にて敷設し、1200℃の温度で2時間焼成して厚みが約3μmのPtからなる第一導電膜2を積層し、次いでPtからなる第一導電膜2上に、有機物バインダーに対して平均粒径が1μmのPt（90重量%）－Rh（10重量%）の合金を52重量%含有させたPt－Rhのペーストを乳剤厚み6μmの製版を用いてスクリーン印刷法にて敷設し、1300℃の温度で2時間焼成し、厚み約2μmのPt（90重量%）－Rh（10重量%）からなる第二導電膜3を積層し、次いで有機物バインダーに対して平均粒径1μm程度のチタン酸ジルコン酸鉛（以下PZTと称す。）を70重量%含有させたペーストをスクリーン印刷法にて敷設し、1250℃で2時間焼成して厚みが約14μmの圧電／電歪膜4を形成した。さらに上記PZTからなる圧電／電歪膜4上に有機物バインダーに対してAuを含有させたペーストをスクリーン印刷法にて敷設し、700℃で15分間焼成を行い、厚さ0．8μmの電極膜5を形成して図1に示す圧電／電歪膜型アクチュエータを作製した。

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【００３１】そして、このアクチュエータを構成する圧電／電歪膜４の比誘電率を測定するとともに、圧電／電歪膜４の緻密具合を基準試料と比較した。なお、基準試料とは、圧電／電歪膜４と同一の組成からなるセラミック板の上下面に厚さ０．８μｍの金電極をそれぞれ形成したもので、この基準試料と圧電／電歪膜型アクチュエータの圧電／電歪膜４の結晶状態を電子顕微鏡にて測定し、各ＰＺＴ粒子の粒子径を測定、比較することにより圧電／電歪膜４の緻密具合を確認するとともに、比誘電率はインピーダンスアナライザーによって測定した静電容量から算出した。

【００３２】この結果、表１に見られるように、ＰＺＴ粒子の成長状態が基準試料と同等であることから圧電／電歪膜４の焼結が十分であることが確認できた。その為、圧電／電歪膜４の比誘電率も基準試料と近似しており、所望の圧電／電歪特性が得られることが確認できた。しかも、第一導電膜２とセラミック基板１は十分な密着性を有しており剥離することがなかった。

【００３３】

【表１】

	圧電／電歪膜 PZT 粒子径（μm）	比誘電率
本発明	２．７	２８２０
基準試料	３．１	３２００

【００３４】（実施例２）次に、第二導電膜３の材質をＲｈ（１００重量％）、Ｐｔ（９８重量％）－Ｒｈ（２重量％）の合金、Ｐｔ（９５重量％）－Ｒｈ（５重量％）の合金、Ｐｔ（９８重量％）－Ｗ（２重量％）の合金、Ｐｔ（９６重量％）－Ｗ（４重量％）の合金、Ｐｔ（９２重量％）－Ｗ（８重量％）の合金に代えて実施例１と同様の実験を行った。また、比較例として、セラミ＊

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＊ック基板１と圧電／電歪膜４との間にＰｔからなる第一導電膜２のみを介在させた圧電／電歪膜型アクチュエータ及びセラミック基板１と圧電／電歪膜４との間にＰｔ（９２重量％）－Ｗ（８重量％）の合金からなる第二導電膜３のみを介在させた圧電／電歪膜型アクチュエータを用意して実験を行った。

【００３５】それぞれの結果は表２に示す通りである。

【００３６】この結果、Ｐｔからなる第一導電膜２のみを有する試料Ｎｏ．７は、圧電／電歪膜４を構成するＰＺＴ粒子の粒径が基準試料と比較して小さく、十分に焼結されていないために緻密化されておらず、その結果、比誘電率が１５７０と基準試料に比べて小さかった。

【００３７】また、Ｐｔ－Ｗ合金からなる第二導電膜３のみを有する試料Ｎｏ．８は、圧電／電歪膜４を構成するＰＺＴ粒子の粒径が基準試料とほぼ同径であり、十分に緻密化されているもののセラミック基板１との密着性が悪いために、第二導電膜３が剥離した。

【００３８】これに対し、Ｐｔからなる第一導電膜２上にＰｔより融点の高いＲｈ（１００重量％）、Ｐｔ（９８重量％）－Ｒｈ（２重量％）の合金、Ｐｔ（９８重量％）－Ｗ（２重量％）の合金、Ｐｔ（９６重量％）－Ｗ（４重量％）の合金、Ｐｔ（９２重量％）－Ｗ（８重量％）の合金からなる第二導電膜３を有する試料Ｎｏ．１～６はいずれも圧電／電歪膜４を構成するＰＺＴ粒子の粒径が基準試料とほぼ同径で、十分に緻密化されており、それ故、各試料の圧電／電歪膜４の比誘電率も基準試料と近似しており、所望の圧電／電歪特性が得られることが確認できた。しかも、セラミック基板１側にはＰｔからなる第一導電膜２を有することから十分な密着性を有していた。

【００３９】

【表２】

	第一導電膜（重量％）	第二導電膜（重量％）	第二導電膜の融点（℃）	圧電／電歪膜 PZT 粒子径（μm）	圧電／電歪膜 比誘電率	セラミック基板と導電膜の剥離の有無
１	Ｐｔ（１００）	Ｒｈ(100)	１９５３	３．１	２８７０	○
２		Ｐｔ(98)-Ｒｈ(2)	１７９０	２．５	２０９０	○
３		Ｐｔ(95)-Ｒｈ(5)	１８４０	２．７	２８２０	○
４		Ｐｔ(98)-Ｗ(2)	１８００	２．４	２０８５	○
５		Ｐｔ(96)-Ｗ(4)	１８３０	２．７	２７５０	○
６		Ｐｔ(92)-Ｗ(8)	１９１０	２．９	２９８０	○
※７		——	——	１．８	１５７０	○
※８	——	Ｐｔ(96)-Ｗ(8)	１９１０	２．８	——	×
基準	——	——	——	３．１	３２００	○

基準とは基準試料のことである。
○は剥離なし　×は剥離あり
※は本発明範囲外である。

【0040】（実施例3）次に、図1に示す他の圧電／電歪膜型アクチュエータの具体例について説明する。薄肉のセラミック基板1として、平均粒径0．2μmのY_2O_3を3mol%含有する部分安定化ZrO_2の粉末にアクリル酸エステル共重合体水性エマルジョンを主成分とするバインダーを添加し、ボールミルにて20時間混合した後、テープ状に成形し、1200～1400℃で1～5時間焼成して厚みが約0．2mmのジルコニアセラミックスからなるセラミック基板1を製作した。そして、このセラミック基板1上に、有機物バインダーに対して平均粒径が1μmのPtを69重量%含有させたPtのペーストを乳剤厚み6μmの製版を用いてスクリーン印刷法にて敷設し、1200℃の温度で2時間焼成して厚みが約3μmのPtからなる第一導電膜2を積層し、次いでPtからなる第一導電膜2上に、有機物バインダーに対して平均粒径が1μmのPt（98重量%）－Au（2重量%）合金を52重量%含有させたPt－Auのペーストを乳剤厚み6μmの製版を用いてスクリーン印刷法にて敷設し、1100℃の温度で2時間焼成し、厚み約2μmのPt（98重量%）－Au（2重量%）からなる第二導電膜3を積層し、次いで有機物バインダーに対して平均粒径1μm程度のチタン酸ジルコン酸鉛（以下PZTと称す。）を70重量%含有させたペーストをスクリーン印刷法にて敷設し、1250℃で2時間焼成して厚みが約14μmの圧電／電歪膜4を形成した。さらに上記PZTからなる圧電／電歪膜4上に有機物バインダーに対してAuを含有させたペーストをスクリーン印刷法にて敷設し、700℃で15分間焼成を行い、厚さ0．8μm の電極膜5を形成して図1に示す圧電／電歪膜型アクチュエータを作製した。

【0041】そして、このアクチュエータを構成する圧電／電歪膜4の比誘電率を測定するとともに、圧電／電歪膜4の緻密具合を基準試料と比較した。なお、基準試料とは、圧電／電歪膜4と同一の組成からなるセラミック板の上下面に厚さ0．8μmの金電極をそれぞれ形成したもので、この基準試料と圧電／電歪膜型アクチュエータの圧電／電歪膜4の結晶状態を電子顕微鏡にて測定し、各PZT粒子の粒子径を測定、比較することにより圧電／電歪膜4の緻密具合を確認するとともに、比誘電率はインピーダンスアナライザーによって測定したコンデンサー容量から算出した。

【0042】この結果、表3に見られるように、PZT粒子の成長状態が基準試料と同等であることから圧電／電歪膜4の焼結が十分であることが確認できた。その為、圧電／電歪膜4の比誘電率も基準試料と近似しており、所望の圧電／電歪特性が得られることが確認できた。しかも、第一導電膜2とセラミック基板1は十分な密着性を有しており剥離することがなかった。

【0043】

【表3】

	圧電／電歪膜 PZT 粒子径（μm）	比誘電率
本発明	2．7	2870
基準試料	3．1	3200

【0044】（実施例4）次に、第二導電膜3の材質をPt（95重量%）－Au（5重量%）の合金、Pt（90重量%）－Au（10重量%）の合金、Pt（98重量%）－Ag（2重量%）の合金、Pt（95重量%）－Ag（5重量%）の合金、Pt（90重量%）－Ag（10重量%）の合金、Pt（90重量%）－Pd（10重量%）の合金、Pt（85重量%）－Pd（15重量%）の合金、Pt（80重量%）－Pd（20重量%）の合金に代えて実施例1と同様の実験を行った。また、比較例として、セラミック基板1と圧電／電歪膜4との間にPtからなる第一導電膜2のみを介在させた圧電／電歪膜型アクチュエータ及びセラミック基板1と圧電／電歪膜4との間にPt（95重量%）－Au（5重量%）の合金からなる第二導電膜3のみを介在させた圧電／電歪膜型アクチュエータを用意して実験を行った。

【0045】それぞれの結果は表4に示す通りである。

【0046】この結果、Ptからなる第一導電膜2のみを有する試料No．19は、圧電／電歪膜4を構成するPZT粒子の粒径が基準試料と比較して小さく、十分に焼結されていないために緻密化されておらず、その結果、比誘電率が1570と基準試料に比べて小さかった。

【0047】また、Pt－W合金からなる第二導電膜3のみを有する試料No．20は、圧電／電歪膜4を構成するPZT粒子の粒径が基準試料とほぼ同径であり、十分に緻密化されているもののセラミック基板1との密着性が悪いために、第二導電膜3が剥離した。

【0048】これに対し、Ptからなる第一導電膜2上にPtより融点の低いPt（95重量%）－Au（5重量%）の合金、Pt（90重量%）－Au（10重量%）の合金、Pt（98重量%）－Ag（2重量%）の合金、Pt（95重量%）－Ag（5重量%）の合金、Pt（90重量%）－Ag（10重量%）の合金、Pt（90重量%）－Pd（10重量%）の合金、Pt（85重量%）－Pd（15重量%）の合金、Pt（80重量%）－Pd（20重量%）の合金からなる第二導電膜3を用いた試料No．11～18はいずれも圧電／電歪膜4を構成するPZT粒子の粒径が基準試料とほぼ同径で、十分に緻密化されており、それ故、各試料の圧電／電歪膜4の比誘電率も基準試料と近似しており、所望の圧電／電歪特性が得られることが確認できた。しかも、セラミック基板1側にはPtからなる第一導電膜2を有

することから十分な密着性を有していた。

【0049】

＊【表4】

	第一導電膜（重量%）	第二導電膜（重量%）	第二導電膜の融点（℃）	圧電／電歪膜 PZT 粒子径（μm）	圧電／電歪膜 比誘電率	セラミック基板と導電膜の剥離の有無
11	Pt（100）	Pt(95)-Au(5)	1660	2.8	2920	○
12		Pt(90)-Au(10)	1590	3.0	3020	○
13		Pt(98)-Ag(2)	1700	2.8	2930	○
14		Pt(95)-Ag(5)	1420	3.0	3015	○
15		Pt(90)-Ag(10)	1180	3.0	3023	○
16		Pt(90)-Pd(10)	1740	2.5	2190	○
17		Pt(85)-Pd(15)	1730	2.7	2750	○
18		Pt(80)-Pd(20)	1710	2.8	2880	○
※19		———	1772	1.8	1570	○
※20	———	Pt(95)-Au(5)	1660	2.8	———	×
基準	———	———	———	3.1	3200	○

基準とは基準材料のことである。
○は剥離なし　×は剥離あり
※は本発明範囲外である。

【0050】

【発明の効果】以上のように、本発明によれば、薄肉のセラミック基板上にＰｔからなる第一導電膜を形成し、該第一導電膜上に第一導電膜より融点の高いＰｔ－Ｗ、Ｐｔ－Ｒｈ、あるいはＲｈからなる第二導電膜を積層するか、あるいは上記第一導電膜上に第一導電膜より融点の低いＰｔ－Ａｕ、Ｐｔ－Ａｇ、あるいはＰｔ－Ｐｄからなる第二導電膜を積層し、該第二導電膜上に圧電／電歪膜及び電極膜を順次積層一体化して圧電／電歪膜型アクチュエータを構成したことから、いずれにおいても圧電／電歪膜４を緻密化させることができるため、所望の圧電／電歪特性を得ることができ、低電圧駆動でありながら大きな屈曲変位を得ることができるとともに、十分な密着性を有することから圧電／電歪膜型アクチュエー※タを変位させたとしても剥離を生じることがない。

【図面の簡単な説明】

【図１】本発明の圧電／電歪膜型アクチュエータの一例を示す斜視図である。

【図２】本発明の圧電／電歪膜型アクチュエータの他の例を示す斜視図である。

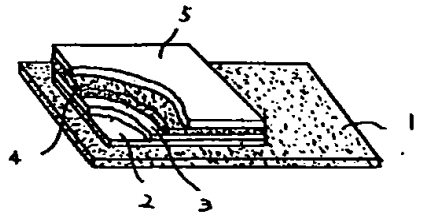
【図３】一般的な圧電／電歪膜型アクチュエータの一例を示す斜視図である。

【符号の説明】

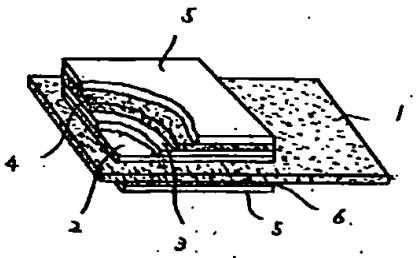
１・・・セラミック基板　２・・・第一導電膜　３・・・第二導電膜

４・・・圧電／電歪膜　５・・・電極膜　６・・・下側電極膜

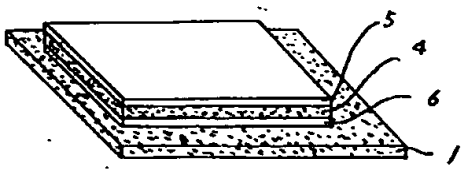
【図１】



【図２】



【図3】



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application converted registration]

[Date of final disposal for application]

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decision of rejection]

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decision of rejection]

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The piezo-electricity / electrostriction membrane type actuator which forms the first electric conduction film which consists of Pt on the ceramic substrate of thin meat, carries out the laminating of the second electric conduction film which consists of Pt-W, Pt-Rh, Rh or Pt-Au, Pt-Ag, or Pt-Pd on this first electric conduction film, and comes to carry out the laminating unification of piezo-electricity / electrostriction film, and the electrode layer on this second electric conduction film one by one.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is suitable for an ink jet recording head, a microphone, an oscillating object, an oscillation object, various displacement sensors, a pump, a switch, etc. about the piezo-electricity / electrostriction membrane type actuator which comes to carry out the laminating unification of piezo-electricity / electrostriction film, and the electrode layer one by one through the second electric conduction film which consists of the first electric conduction film which consists of Pt on the ceramic substrate of thin meat, and an alloy containing Pt.
[0002]
[Description of the Prior Art] In recent years, in the precision processing field or the optical field, the position control in submicron order is called for and the piezo-electricity / electrostriction membrane type actuator using the phenomenon of the variation rate based on the inverse piezolectric effect and electrostrictive effect which happen when electric field are added to this position control at piezo-electricity / electrostriction ingredients, such as a ferroelectric, or its reverse are used.
[0003] For example, in the ink jet recording head, piezo-electricity / electrostriction membrane type actuators, such as a uni-morph mold and a bimorph mold, are used, and properties, such as a miniaturization, densification, low-battery actuation, and high-speed responsibility, are demanded.
[0004] This actuator is what is called a uni-morph mold so that the structure of common piezo-electricity / electrostriction membrane type actuator to drawing 4 may be shown. While forming the bottom electrode layer 6 which consists of Pt with high this ceramic substrate 1 and adhesion on the insulating ceramic substrate 1 of thin meat On this bottom electrode layer 6, PZT, magnesium niobic acid lead, There were some which carried out the laminating of the piezo-electricity / the electrostriction film 4 which consists of piezoelectric material, such as nickel niobic acid lead and antimony tin lead, and carried out the laminating unification of the upside electrode layer 5 which consists of refractory metals, such as Pt, Pd, and Rh, on above-mentioned piezo-electricity / electrostriction film 4 further (refer to JP,6-260694,A).
[0005] The thing in which the piezo-electricity / electrostriction actuator 7 which consists of the bottom electrode layer 6, piezo-electricity / electrostriction film 4, and an upside electrode layer 5 were formed on such a ceramic substrate 1 had the advantage that the big crookedness displacement by the transversal effect which is electric-field induction distortion was obtained while having high-speed responsibility by low-battery actuation.
[0006] However, if the laminating unification of direct piezo-electricity / the electrostriction film 4 is carried out on the bottom electrode layer 6 which consists of Pt since eburnation of piezo-electricity / the electrostriction film 4 cannot fully be carried out, even if it energizes to the bottom electrode layer 6 and the upside electrode layer 5 and makes piezo-electricity / electrostriction film 4 generate electric-field induction distortion, desired piezo-electricity / electrostriction property obtain -- not having -- big crookedness -- the technical problem that a variation rate was not obtained occurred.
[0007]

[Means for Solving the Problem] Then, when these artificers inquire about the cause to which eburnation of the piezo-electricity / the electrostriction film which carried out the laminating on the electric conduction film which consists of Pt cannot be carried out, they set to the heat-treatment-temperature field (900-1300 degrees C) of the piezo-electricity / electrostriction film which consists of the above-mentioned piezoelectric material. The knowledge of the ability not to carry out [since adhesion with the electrode layer which consists of piezoelectric material which constitutes piezo-electricity / electrostriction film, and Pt is high, contraction of piezoelectric material is checked, consequently] the eburnation of piezo-electricity / the electrostriction film was carried out.
[0008] About the piezo-electricity / electrostriction membrane type actuator with which this artificer fully does eburnation of piezo-electricity / the electrostriction film, and desired piezo-electricity / electrostriction property are acquired, when research is repeated further wholeheartedly, and between the electric conduction film, and the piezo-electricity / electrostriction film which consists of Pt It traced that eburnation of piezo-electricity / the electrostriction film was carried out, and desired piezo-electricity / electrostriction property could be demonstrated by making the low electric conduction film of the melting point intervene from the electric conduction film which the high electric conduction film of the melting point is made to intervene from the electric conduction film which consists of Pt, or becomes reverse from Pt.
[0009] Namely, this invention forms the first electric conduction film which consists of Pt on the ceramic substrate of thin meat. On this first electric conduction film, Pt-W with the melting point higher than the first electric conduction film, Pt-Rh, Pt-Au with the melting point lower than the second electric conduction film or the above-mentioned first electric conduction film which consists of either of the Rh (s), The laminating of the second electric conduction film which consists of Pt-Ag or Pt-Pd is carried out, the laminating unification of piezo-electricity / electrostriction film, and the electrode layer is carried out one by one on this second electric conduction film, and piezo-electricity / electrostriction membrane type actuator is constituted.
[0010]
[Function] According to the invention in this application, since the first electric conduction film which consists of Pt is formed on the ceramic substrate of thin meat, even if it can raise adhesion with a ceramic substrate and makes piezo-electricity / electrostriction film drive, the first electric conduction film does not exfoliate from a ceramic substrate.
[0011] According to this invention, on the first electric conduction film which consists of the above Pt Moreover, Pt-W with the melting point higher than the first electric conduction film, Piezo-electricity / electrostriction film through the second electric conduction film which consists of Pt-Rh or Rh [whether laminating unification is carried out and] Or since the laminating unification of piezo-electricity / the electrostriction film has been carried out through the second electric conduction film which consists of Pt-Au with the melting point lower than the first electric conduction film, Pt-Ag, or Pt-Pd on the first electric conduction film which consists of the above Pt, eburnation of piezo-electricity / the electrostriction film can be carried out. Namely, by using one of the metals and alloys of Pt-W with the melting point higher than the first electric conduction film, Pt-Rh, and Rh as the second electric conduction film Since the adhesion force of the piezoelectric material and the second electric conduction film which constitute piezo-electricity / electrostriction film can be reduced in the heat-treatment-temperature field (900-1300 degrees C) of piezo-electricity / electrostriction film, become easy to contract piezoelectric material. By being able to carry out eburnation of piezo-electricity / the electrostriction film, and using one alloy of Pt-Au with the melting point lower than the first electric conduction film, Pt-Ag, and Pt-Pd as the second electric conduction film In the heat-treatment-temperature field (900-1300 degrees C) of piezo-electricity / electrostriction film, since softening or rigidity can be reduced, piezoelectric material becomes easy to contract the front face of the second electric conduction film, and eburnation of piezo-electricity / the electrostriction film can be carried out.
[0012]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained. In addition, the same sign shows the same part as drawing 4.

[0013] Drawing 1 is the perspective view showing an example of the piezo-electricity / electrostriction membrane type actuator of this invention. This actuator is called a uni-morph mold and forms the first electric conduction film 2 which consists of Pt on the ceramic substrate 1 of thin meat. On this first electric conduction film 2, Pt-W with the melting point higher than the first electric conduction film 2, Pt-Rh, Carry out the laminating of the second electric conduction film 3 which consists of either of the Rh(s), or on the above-mentioned first electric conduction film 2 Pt-Au with the melting point lower than the first electric conduction film 2, After carrying out the laminating of the second electric conduction film 3 which consists of Pt-Ag or Pt-Pd and carrying out the laminating of piezo-electricity / the electrostriction film 4 on this second electric conduction film 3, it is what carried out the laminating of the electrode layer 5 on piezo-electricity / electrostriction film 4, and each film 2-5 carries out laminating unification one by one on a ceramic substrate 1 by heat treatment.
[0014] Moreover, drawing 2 is the perspective view showing other examples of the piezo-electricity / electrostriction membrane type actuator of this invention, and this actuator is what is called a bimorph mold. The first electric conduction film 2 which consists of Pt is formed in the vertical side of the ceramic substrate 1 of thin meat. On this first electric conduction film 2, Pt-W with the melting point higher than the first electric conduction film 2, Pt-Rh, Carry out the laminating of the second electric conduction film 3 which consists of either of the Rh(s), or on the above-mentioned first electric conduction film 2 Pt-Au with the melting point lower than the first electric conduction film 2, After carrying out the laminating of the second electric conduction film 3 which consists of Pt-Ag or Pt-Pd and carrying out the laminating of piezo-electricity / the electrostriction film 4 on this second electric conduction film 3, it is what carried out the laminating of the electrode layer 5 on piezo-electricity / electrostriction film 4, and each film 2-5 carries out laminating unification one by one on a ceramic substrate 1 by heat treatment.
[0015] In the piezo-electricity / electrostriction membrane type actuator shown in drawing 1 and drawing 2 , as construction material which constitutes a ceramic substrate 1 Alumina ceramics, silicon carbide ceramics, the silicon nitride ceramics, The ceramics which has the crystal structure of perovskite molds, such as zirconia ceramics or a lanthanum chromite system, can be used. Since the ceramics which has the crystal structure of zirconia ceramics and a perovskite mold also especially in these has few reactions with the first electrode layer 2 which consists of Pt, Since the constituent of a ceramic substrate 1 can prevent being spread on the piezo-electricity / electrostriction film 4 which carries out a laminating on the first electric conduction film 2, the property of piezo-electricity / electrostriction film 4 is not degraded.
[0016] In addition, what is necessary is to use the first electric conduction film 2 and/or the first electric conduction film 3 as a bottom electrode, when a ceramic substrate 1 is the insulating ceramics in making piezo-electricity / electrostriction film 4 drive, and just to let a ceramic substrate 1 be a bottom electrode, in being the ceramics with which a ceramic substrate 1 has conductivity.
[0017] moreover, as construction material which constitutes the piezo-electricity / electrostriction film 4 which generates electric-field induction distortion The ingredient which uses PZT (PZT system) as a principal component, the ingredient which uses magnesium niobic acid lead (PMN system) as a principal component, The ingredient which uses nickel niobic acid lead as a principal component, the ingredient which uses antimony stannic-acid lead as a principal component, The ingredient which uses lead titanate as a principal component, the ingredient which uses barium titanate as a principal component, Furthermore, the composite material of these principal components etc. can be used. It is desirable to form with the ingredient which uses as a principal component the ingredient or nickel niobic acid lead which uses magnesium niobic acid lead, lead zirconate, and lead titanate as a principal component preferably, magnesium niobic acid lead, lead zirconate, and lead titanate.
[0018] Furthermore, as construction material of the electrode layer 5 which carries out a laminating, the electrode material which uses alloys, such as refractory metals, such as Pt, Au, Pb, and Rh, and Pt-Au, Pb-Ag, Pt-Pb, as a principal component can be used on piezo-electricity / electrostriction film 4.
[0019] And it is important for the first electric conduction film 2 formed on the above-mentioned ceramic substrate 1 to use Pt. Since Above Pt is excellent in adhesion with a ceramic substrate 1 as

compared with other refractory metals, even if it makes piezo-electricity / electrostriction film 4 drive and carries out the crookedness variation rate of the ceramic substrate 1, it does not exfoliate.
[0020] Moreover, it is important to make the second electric conduction film 3 which the second electric conduction film 3 which consists of Pt-W with the melting point higher than the first electric conduction film 2, Pt-Rh, or Rh is made to intervene between the first electric conduction film 2, and the piezo-electricity / electrostriction film 4 which consists of the above Pt, or consists of Pt-Au with the melting point lower than the first electric conduction film 2, Pt-Ag, or Pt-Pd intervene.
[0021] By namely, the thing established for the high second electric conduction film 3 of the melting point from Pt on the first electric conduction film 2 which consists of Pt In order to carry out eburnation of the piezo-electricity / the electrostriction film 4 formed on the above-mentioned second electric conduction film 3, even if it adds heat treatment Since the front face of the first electric conduction film 2 does not soften or rigidity does not fall in the heat-treatment-temperature field (900-1300 degrees C) of said piezoelectric material, Since the adhesion force between the piezoelectric material and the second electric conduction film 3 which constitute piezo-electricity / electrostriction film 4 becomes small and it becomes easy to contract piezoelectric material, By being able to carry out eburnation of piezo-electricity / the electrostriction film 4, and forming the low second electric conduction film 3 of the melting point from Pt on another side and the first electric conduction film 2 which consists of Pt If heat treatment is added in order to carry out eburnation of the piezo-electricity / the electrostriction film 4 formed on the above-mentioned second electric conduction film 3 Since the front face of the first electric conduction film 2 can be softened greatly or rigidity can be greatly reduced in the heat-treatment-temperature field (900-1300 degrees C) of said piezoelectric material, it becomes easy to contract the piezoelectric material which constitutes piezo-electricity / electrostriction film 4, and eburnation of piezo-electricity / the electrostriction film 4 can be carried out.
[0022] And since each of Pt-W with the melting point higher than Pt, Pt-Rh, Rh or Pt-Au with the melting point lower than Pt, Pt-Ag, and Pt-Pd serves as an alloy containing Pt, or Pt from Rh which is easy to get used, it can raise adhesion with the first electric conduction film 2.
[0023] while desired piezo-electricity / electrostriction property can be acquired and it will be low-battery actuation, if piezo-electricity / electrostriction film 4 is made to drive since eburnation of piezo-electricity / the electrostriction film 4 can be carried out even if it uses the second electric conduction film 3 which consists of which construction material for the reason -- big crookedness -- the piezo-electricity / electrostriction membrane type actuator with which a variation rate is obtained can be obtained.
[0024] In order to acquire such effectiveness, as the second electric conduction film 3 However, Pt-W with the melting point higher than Pt, What has the melting point higher 50 degrees C or more than Pt which constitutes the first electric conduction film 2 when using Pt-Rh and Rh is desirable. Moreover, when using Pt-Au with the melting point lower than Pt, Pt-Ag, and Pt-Pd as the second electric conduction film 3, what has the melting point lower than Pt which constitutes the first electric conduction film 2 in the range which is 30-400 degrees C is desirable.
[0025] Moreover, in order to make electric-field induction distortion generated with piezo-electricity / electrostriction film 4 transmit to a ceramic substrate 1 efficiently and to carry out a crookedness variation rate as a design, it is good to set preferably 1-5 micrometers of sum total thickness width of face of the first electric conduction film 2 and the second electric conduction film 3 to 3-4 micrometers. When the sum total thickness width of face of these electric conduction film 2 and 3 becomes thicker than 5 micrometers, it is because the electric-field induction distortion of piezo-electricity / electrostriction film 4 is absorbed by the electric conduction film 2 and 3, so the crookedness variation rate of the ceramic substrate 1 of thin meat cannot be carried out as a design. On the contrary, formation of the electric conduction film 2 and 3 which had uniform thickness width of face in less than 1 micrometer is difficult, and it is because piezo-electricity / electrostriction property is degraded when there is a pinhole etc.
[0026] By the way, in order to manufacture the piezo-electricity / electrostriction membrane type actuator shown in drawing 1 or drawing 2 The ceramic substrate 1 of the thin meat which consists of

said ceramic ingredient sintered beforehand is prepared. one principal plane or vertical side of this substrate 1 -- the paste and slurry of Pt -- screen printing and DIPINNGU -- law -- Or after forming the first electric conduction film 2 which lays by the film means forming of common knowledge, such as spreading, heat-treats at the temperature of 500-1400 degrees C, and consists of Pt, On this first electric conduction film 2, the alloy of Pt-W or Pt-Rh with the melting point higher than Pt, or the paste and slurry of Rh -- screen printing and DIPINNGU -- law -- By the film means forming of common knowledge, such as spreading, laying, and heat-treating in a 1000-1800-degree C temperature requirement, or Pt-W, Carry out the laminating of the second electric conduction film 3 which consists of Pt-Rh or Rh, or on the above-mentioned first electric conduction film 2 Pt-Au with the melting point lower than Pt, the paste and slurry of an alloy of Pt-Ag and Pt-Pd -- screen printing and DIPINNGU -- law -- Or the film means forming of common knowledge, such as spreading, lays, and the laminating of the second electric conduction film 3 which consists of Pt-Au, Pt-Ag, or Pt-Pd is carried out by heat-treating in a 500-1300-degree C temperature requirement. Furthermore, said piezoelectric material which constitutes piezo-electricity / electrostriction film 4 on the above-mentioned second electric conduction film 3 (it PZT(s)) the paste and slurry containing PMN etc. -- screen printing and DIPINNGU -- the film means forming of common knowledge, such as law or spreading, laying, and, after carrying out the laminating of piezo-electricity / the electrostriction film 4 by heat-treating at the temperature of 1100-1400 degrees C the paste and slurry containing said electrode material which furthermore constitutes an electrode layer 5 on piezo-electricity / electrostriction film 4 -- screen printing and DIPINNGU, after the film means forming of common knowledge, such as law or spreading, lays What is necessary is just to carry out the laminating unification of the electrode layer 5 by heat-treating at the temperature of 500-1200 degrees C.

[0027] since good piezo-electricity / electrostriction property can be demonstrated in this way from piezo-electricity / electrostriction film 4 having sintered nearly precisely thoroughly according to the piezo-electricity / the electrostriction membrane type actuator of this invention, while it is low-battery actuation -- the big crookedness as a design -- while a variation rate is obtained, a speed of response can be raised.

[0028] If the piezo-electricity / electrostriction membrane type actuator of this invention are used for example, for an ink jet recording head for the reason, while being able to raise the discharge quantity of ink, printing speed can be sped up and it can be suitably used for others also as a microphone, an oscillating object, an oscillation object, various displacement sensors, a pump, a switch, etc.

[0029] (Example) The example of the piezo-electricity / electrostriction membrane type actuator shown in drawing 1 is explained hereafter.

[0030] (Example 1) as the ceramic substrate 1 of thin meat -- Y2 O3 [with a mean particle diameter of 0.2 micrometers] three-mol% -- partial stabilization ZrO2 to contain After adding to powder the binder which uses an acrylic ester copolymer aquosity emulsion as a principal component and mixing with a ball mill for 20 hours, it fabricated in the shape of a tape, and the ceramic substrate 1 which it calcinates at 1200-1400 degrees C for 1 to 5 hours, and thickness becomes from the zirconia ceramics which are about 0.2mm was manufactured. And the paste of Pt which made Pt whose mean particle diameter is 1 micrometer contain 69% of the weight to an organic substance binder is laid with screen printing on this ceramic substrate 1 using platemaking with an emulsion thickness of 6 micrometers. The laminating of the first electric conduction film 2 with which it calcinates at the temperature of 1200 degrees C for 2 hours, and thickness consists of Pt which is about 3 micrometers is carried out. Subsequently, on the first electric conduction film 2 which consists of Pt, the paste of Pt-Rh which made the alloy of Pt(90 % of the weight)-Rh (10 % of the weight) whose mean particle diameter is 1 micrometer contain 52% of the weight to an organic substance binder is laid with screen printing using platemaking with an emulsion thickness of 6 micrometers. It calcinates at the temperature of 1300 degrees C for 2 hours, the laminating of the second electric conduction film 3 which consists of Pt(90 % of the weight)-Rh (10 % of the weight) with a thickness of about 2 micrometers is carried out, and it is [as opposed to / subsequently / an organic substance binder] titanic-acid lead zirconate (Following PZT is called.) of about 1 micrometer of mean diameters. The paste made to contain 70% of the weight was laid with

screen printing, it calcinated at 1250 degrees C for 2 hours, and the piezo-electricity / electrostriction film 4 whose thickness is about 14 micrometers were formed. The paste which made Au contain to an organic substance binder on the piezo-electricity / electrostriction film 4 which furthermore consists of the above PZT is laid with screen printing, baking is performed for 15 minutes at 700 degrees C, and it is 0.8 micrometers in thickness. The piezo-electricity / electrostriction membrane type actuator which forms an electrode layer 5 and is shown in drawing 1 were produced.

[0031] And while measuring the specific inductive capacity of the piezo-electricity / electrostriction film 4 which constitutes this actuator, the precise condition of piezo-electricity / electrostriction film 4 was compared with the authentic sample. In addition, an authentic sample is what formed the golden electrode with a thickness of 0.8 micrometers in the vertical side of the ceramic plate which consists of the same presentation as piezo-electricity / electrostriction film 4, respectively. While checking the precise condition of piezo-electricity / electrostriction film 4 by measuring the crystallized state of the piezo-electricity / electrostriction film 4 of this authentic sample, and a piezo-electricity / electrostriction membrane type actuator with an electron microscope, and measuring and comparing the particle diameter of each PZT particle Specific inductive capacity was computed from the electrostatic capacity measured with the impedance analyzer.

[0032] Consequently, since the growth condition of a PZT particle was equivalent to the authentic sample as seen in a table 1, sintering of piezo-electricity / electrostriction film 4 came out enough, and a certain thing has been checked. For the reason, the specific inductive capacity of piezo-electricity / electrostriction film 4 was also approximated with the authentic sample, and it has checked that desired piezo-electricity / electrostriction property were acquired. And the first electric conduction film 2 and a ceramic substrate 1 have sufficient adhesion, and did not exfoliate.

[0033]

[A table 1]

	圧電／電歪膜 PZT 粒子径 (μm)	比誘電率
本発明	2．7	2820
基準試料	3．1	3200

[0034] The construction material of the second electric conduction film 3 Next, the alloy of Rh (100 % of the weight) and Pt(98 % of the weight)-Rh (2 % of the weight), (Example 2) It replaced with the alloy of Pt(95 % of the weight)-Rh (5 % of the weight), the alloy of Pt(98 % of the weight)-W (2 % of the weight), the alloy of Pt(96 % of the weight)-W (4 % of the weight), and the alloy of Pt(92 % of the weight)-W (8 % of the weight), and the same experiment as an example 1 was conducted. Moreover, it experimented by preparing the piezo-electricity / electrostriction membrane type actuator which made only the second electric conduction film 3 which consists of an alloy of Pt(92 % of the weight)-W (8 % of the weight) intervene between the piezo-electricity / electrostriction membrane type actuators, and the ceramic substrates 1, and the piezo-electricity / electrostriction film 4 which made only the first electric conduction film 2 which consists of Pt intervene between a ceramic substrate 1, and the piezo-electricity / electrostriction film 4 as an example of a comparison.

[0035] Each result is as being shown in a table 2.

[0036] Consequently, the particle size of the PZT particle which constitutes piezo-electricity / electrostriction film 4 was small as compared with the authentic sample, and since sample No.7 which have only the first electric conduction film 2 which consists of Pt were not fully sintered, eburnation of them was not carried out, consequently specific inductive capacity was small [seven] compared with 1570 and an authentic sample.

[0037] Moreover, although the particle size of the PZT particle which constitutes piezo-electricity / electrostriction film 4 is a diameter of said mostly with an authentic sample and eburnation of the

sample No.8 which have only the second electric conduction film 3 which consists of a Pt-W alloy was fully carried out, since adhesion with a ceramic substrate 1 was bad, the second electric conduction film 3 exfoliated.

[0038] On the first electric conduction film 2 which consists of Pt, on the other hand, Rh with the melting point higher than Pt (100 % of the weight), The alloy of Pt(98 % of the weight)-Rh (2 % of the weight), the alloy of Pt(98 % of the weight)-W (2 % of the weight), The particle size of the PZT particle from which each sample No.1-6 which has the second electric conduction film 3 which consists of an alloy of Pt(96 % of the weight)-W (4 % of the weight) and an alloy of Pt(92 % of the weight)-W (8 % of the weight) constitutes piezo-electricity / electrostriction film 4 is a diameter of said mostly with an authentic sample. Eburnation is fully carried out, so, the specific inductive capacity of the piezo-electricity / electrostriction film 4 of each sample was also approximated with the authentic sample, and it has checked that desired piezo-electricity / electrostriction property were acquired. And in the ceramic substrate 1 side, it had sufficient adhesion from having the first electric conduction film 2 which consists of Pt.

[0039]

[A table 2]

	第一導電膜（重量%）	第二導電膜（重量%）	第二導電膜の融点（℃）	圧電／電歪膜 PZT 粒子径（μm）	比誘電率	セラミック基板と導電膜の剥離の有無
1	Pt（100）	Rh(100)	1963	3.1	2870	○
2		Pt(98)-Rh(2)	1790	2.5	2090	○
3		Pt(95)-Rh(5)	1840	2.7	2820	○
4		Pt(98)-W(2)	1800	2.4	2085	○
5		Pt(96)-W(4)	1830	2.7	2750	○
6		Pt(92)-W(8)	1910	2.9	2980	○
※7		——	——	1.8	1570	○
※8	——	Pt(96)-W(8)	1910	2.8	——	×
基準	——	——	——	3.1	3200	○

基準とは基準試料のことである。
○は剥離なし　×は剥離あり
※は本発明範囲外である。

[0040] (Example 3) Next, the example of other piezo-electricity / electrostriction membrane type actuators which are shown in drawing 1 is explained. as the ceramic substrate 1 of thin meat -- Y2 O3 [with a mean particle diameter of 0.2 micrometers] three-mol% -- partial stabilization ZrO2 to contain After adding to powder the binder which uses an acrylic ester copolymer aquosity emulsion as a principal component and mixing with a ball mill for 20 hours, it fabricated in the shape of a tape, and the ceramic substrate 1 which it calcinates at 1200-1400 degrees C for 1 to 5 hours, and thickness becomes from the zirconia ceramics which are about 0.2mm was manufactured. And the paste of Pt which made Pt whose mean particle diameter is 1 micrometer contain 69% of the weight to an organic substance binder is laid with screen printing on this ceramic substrate 1 using platemaking with an emulsion thickness of 6 micrometers. The laminating of the first electric conduction film 2 with which it calcinates at the temperature of 1200 degrees C for 2 hours, and thickness consists of Pt which is about 3 micrometers is carried out. Subsequently, on the first electric conduction film 2 which consists of Pt, the paste of Pt-Au which made the Pt(98 % of the weight)-Au (2 % of the weight) alloy whose mean particle diameter is 1 micrometer contain 52% of the weight to an organic substance binder is laid with screen printing using platemaking with an emulsion thickness of 6 micrometers. It calcinates at the temperature of 1100 degrees C for 2 hours, the laminating of the second electric conduction film 3

which consists of Pt(98 % of the weight)-Au (2 % of the weight) with a thickness of about 2 micrometers is carried out, and it is [as opposed to / subsequently / an organic substance binder] titanic-acid lead zirconate (Following PZT is called.) of about 1 micrometer of mean diameters. The paste made to contain 70% of the weight was laid with screen printing, it calcinated at 1250 degrees C for 2 hours, and the piezo-electricity / electrostriction film 4 whose thickness is about 14 micrometers were formed. The paste which made Au contain to an organic substance binder on the piezo-electricity / electrostriction film 4 which furthermore consists of the above PZT is laid with screen printing, baking is performed for 15 minutes at 700 degrees C, and it is 0.8 micrometers in thickness. The piezo-electricity / electrostriction membrane type actuator which forms an electrode layer 5 and is shown in drawing 1 were produced.

[0041] And while measuring the specific inductive capacity of the piezo-electricity / electrostriction film 4 which constitutes this actuator, the precise condition of piezo-electricity / electrostriction film 4 was compared with the authentic sample. In addition, an authentic sample is what formed the golden electrode with a thickness of 0.8 micrometers in the vertical side of the ceramic plate which consists of the same presentation as piezo-electricity / electrostriction film 4, respectively. While checking the precise condition of piezo-electricity / electrostriction film 4 by measuring the crystallized state of the piezo-electricity / electrostriction film 4 of this authentic sample, and a piezo-electricity / electrostriction membrane type actuator with an electron microscope, and measuring and comparing the particle diameter of each PZT particle Specific inductive capacity was computed from the capacitor capacity measured with the impedance analyzer.

[0042] Consequently, since the growth condition of a PZT particle was equivalent to the authentic sample as seen in a table 3, sintering of piezo-electricity / electrostriction film 4 came out enough, and a certain thing has been checked. For the reason, the specific inductive capacity of piezo-electricity / electrostriction film 4 was also approximated with the authentic sample, and it has checked that desired piezo-electricity / electrostriction property were acquired. And the first electric conduction film 2 and a ceramic substrate 1 have sufficient adhesion, and did not exfoliate.

[0043]

[A table 3]

	圧電／電歪膜 PZT 粒子径 (μm)	比誘電率
本発明	2．7	2870
基準試料	3．1	3200

[0044] The construction material of the second electric conduction film 3 Next, the alloy of Pt(95 % of the weight)-Au (5 % of the weight), (Example 4) The alloy of Pt(90 % of the weight)-Au (10 % of the weight), the alloy of Pt(98 % of the weight)-Ag (2 % of the weight), The alloy of Pt(95 % of the weight)-Ag (5 % of the weight), the alloy of Pt(90 % of the weight)-Ag (10 % of the weight), It replaced with the alloy of Pt(90 % of the weight)-Pd (10 % of the weight), the alloy of Pt(85 % of the weight)-Pd (15 % of the weight), and the alloy of Pt(80 % of the weight)-Pd (20 % of the weight), and the same experiment as an example 1 was conducted. Moreover, it experimented by preparing the piezo-electricity / electrostriction membrane type actuator which made only the second electric conduction film 3 which consists of an alloy of Pt(95 % of the weight)-Au (5 % of the weight) intervene between the piezo-electricity / electrostriction membrane type actuators, and the ceramic substrates 1, and the piezo-electricity / electrostriction film 4 which made only the first electric conduction film 2 which consists of Pt intervene between a ceramic substrate 1, and the piezo-electricity / electrostriction film 4 as an example of a comparison.

[0045] Each result is as being shown in a table 4.

[0046] Consequently, the particle size of the PZT particle which constitutes piezo-electricity /

electrostriction film 4 was small as compared with the authentic sample, and since sample No.19 which have only the first electric conduction film 2 which consists of Pt were not fully sintered, eburnation of them was not carried out, consequently specific inductive capacity was small [19] compared with 1570 and an authentic sample.

[0047] Moreover, although the particle size of the PZT particle which constitutes piezo-electricity / electrostriction film 4 is a diameter of said mostly with an authentic sample and eburnation of the sample No.20 which have only the second electric conduction film 3 which consists of a Pt-W alloy was fully carried out, since adhesion with a ceramic substrate 1 was bad, the second electric conduction film 3 exfoliated.

[0048] On the first electric conduction film 2 which consists of Pt, on the other hand, the alloy of Pt(95 % of the weight)-Au (5 % of the weight) with the melting point lower than Pt, The alloy of Pt(90 % of the weight)-Au (10 % of the weight), the alloy of Pt(98 % of the weight)-Ag (2 % of the weight), The alloy of Pt(95 % of the weight)-Ag (5 % of the weight), the alloy of Pt(90 % of the weight)-Ag (10 % of the weight), The alloy of Pt(90 % of the weight)-Pd (10 % of the weight), the alloy of Pt(85 % of the weight)-Pd (15 % of the weight), The particle size of the PZT particle from which each sample No.11-18 using the second electric conduction film 3 which consists of an alloy of Pt(80 % of the weight)-Pd (20 % of the weight) constitutes piezo-electricity / electrostriction film 4 is a diameter of said mostly with an authentic sample. Eburnation is fully carried out, so, the specific inductive capacity of the piezo-electricity / electrostriction film 4 of each sample was also approximated with the authentic sample, and it has checked that desired piezo-electricity / electrostriction property were acquired. And in the ceramic substrate 1 side, it had sufficient adhesion from having the first electric conduction film 2 which consists of Pt.

[0049]

[A table 4]

	第一導電膜 (重量%)	第二導電膜 (重量%)	第二導電膜の融点 (℃)	圧電／電歪膜 PZT 粒子径 (μm)	圧電／電歪膜 比誘電率	セラミック基板と導電膜の剥離の有無
11	Pt (100)	Pt(95)-Au(5)	1660	2.8	2920	○
12		Pt(90)-Au(10)	1590	3.0	3020	○
13		Pt(98)-Ag(2)	1700	2.8	2930	○
14		Pt(95)-Ag(5)	1420	3.0	3015	○
15		Pt(90)-Ag(10)	1180	3.0	3023	○
16		Pt(90)-Pd(10)	1740	2.5	2190	○
17		Pt(85)-Pd(15)	1730	2.7	2750	○
18		Pt(80)-Pd(20)	1710	2.8	2880	○
※19		———	1772	1.6	1570	○
※20	———	Pt(95)-Au(5)	1660	2.8	———	×
基準	———	———	———	3.1	3200	○

基準とは基準試料のことである。
○は剥離なし ×は剥離あり
※は本発明範囲外である。

[0050]

[Effect of the Invention] As mentioned above, according to this invention, the first electric conduction film which consists of Pt is formed on the ceramic substrate of thin meat. On this first electric conduction film, Pt-W with the melting point higher than the first electric conduction film, Pt-Rh, Carry out the laminating of the second electric conduction film which consists of Rh, or on the above-mentioned first electric conduction film Or Pt-Au with the melting point lower than the first electric conduction film, From having carried out the laminating of the second electric conduction film which

consists of Pt-Ag or Pt-Pd, having carried out the laminating unification of piezo-electricity / electrostriction film, and the electrode layer one by one on this second electric conduction film, and having constituted piezo-electricity / electrostriction membrane type actuator since eburnation of piezo-electricity / the electrostriction film 4 can be carried out also in any, while desired piezo-electricity / electrostriction property can be acquired and it is low-battery actuation -- big crookedness, while being able to obtain a variation rate Exfoliation is not produced though the variation rate of piezo-electricity / the electrostriction membrane type actuator is carried out, since it has sufficient adhesion.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view showing an example of the piezo-electricity / electrostriction membrane type actuator of this invention.
[Drawing 2] It is the perspective view showing other examples of the piezo-electricity / electrostriction membrane type actuator of this invention.
[Drawing 3] It is the perspective view showing an example of common piezo-electricity / electrostriction membrane type actuator.
[Description of Notations]
1 ... Ceramic substrate 2 ... The first electric conduction film 3 ... The second electric conduction film 4 ... Piezo-electricity / electrostriction film 5 ... Electrode layer 6 ... Bottom electrode layer

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[Translation done.]